

BITTER ROT OF APPLE

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Temperate climate fruits, such as apple, pear, cherry, peach, raspberry, etc., historically have been only marginally successful under Florida conditions because of mild winters. In the last ten to twenty years, both public and private research efforts have developed varieties of temperate fruits which have lower winter chilling requirements and have good horticultural qualities for use as home or commercial crops. Three apple varieties (*Malus sylvestris* Mill.) with chilling requirements between 300-400 hours below 45 F are currently popular in central and north central Florida: 'Anna', 'Dorsett Golden', and 'Ein Shemer' (3). With the advent of these varieties, incidence of apple diseases associated with warm, moist environments has also increased. Bitter rot disease of apple is one such disease and has proven quite devastating on unprotected apples in the Gainesville, Florida area and in Georgia (6).

Bitter rot has been known as a devastating apple disease since the early 1800's, based on detailed descriptions in various early manuscripts. The disease was first positively identified in America in 1867 (2), but the cosmopolitan nature of the pathogen (see Causal Agent section) suggests that it has been around on other substrates for a very long time. The disease occurs in virtually all countries where apples are grown, but the disease apparently causes serious economic damage only in the United States from central Kansas east to the Atlantic and south of 40° latitude to the Gulf Coast (2).

DISEASE SYNDROME: Bitter rot is predominantly a fruit pathogen (3), but the pathogen can also infect stems to cause cankers (2,5,6). Fruits are susceptible from shortly after bloom till harvest (5,6), with most infections either taking place or becoming obvious when fruits are half to full size (2,6). A small gray-brown fleck or circular brown spot is the first symptom. Infections can take place directly through the skin and do not require a wound. Infections on very small fruit remain as small flecks, then enlarge to typical lesions as the fruit ripens (6). Enlarging lesions remain circular, become slightly depressed in the center, and retain their brown color. Each fruit can have one to several infections. As the spots continue to develop, their color often darkens to a dark brown to almost black. When spots are about 0.75 in. (1.90 cm.) in diameter, small raised asexual fruiting bodies (acervuli) form near the center of the lesion (Fig. 1). These acervuli are often arranged in concentric circular patterns but can be irregularly dispersed over the necrotic tissue. Under humid conditions these acervuli exude slimy, salmon-colored masses of conidia which are water-splashed or insect-carried to establish new infections. New acervuli are produced in the newly rotted tissue as the lesion expands. The rotted tissue occupies a cone-shaped area under the circular lesion on the fruit surface, with the apex of the cone at the core of the apple. The rotted tissue is rather firm and watery, and its flavor is said to be inconsistently bitter. (Tasting is not advised as a diagnostic tool because of the possible danger of consuming mycotoxins produced by the many potential fungal fruit rotters.)



The rot can progress to involve the entire fruit, especially if warm, moist conditions prevail. On very old, enlarged spots, asexual sporulation decreases. As the spore masses disappear, the rotted tissue becomes dark brown to black and wrinkled. Fruit drop is a common symptom, but some completely rotted fruit bearing the sexual fruiting bodies (perithecia) sometimes can be found hanging on the tree through the remainder of the season. Apples with small bitter rot lesions can be kept in cold storage, which will stop the progress of the rot, but upon removal from storage, the fruits should be used immediately because rot will rapidly resume at room temperature.

Fig. 1. Bitter rot of 'Golden Dorsett' apple, showing round lesions with concentric pattern of rot and fruiting structures (acervuli) in the center of the lesion. (DPI Photo #702784)

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Stem infections occur on two-year-old and older branches, and appear as oval, sunken cankers with adherent, sometimes longitudinally cracked bark on the surface. The wood beneath the canker is brown and dry down to the pith. Callus can form on the margins, limit the spread, and eventually heal over the canker (2).

CAUSAL AGENT: The pathogen causing bitter rot of apple is *Glomerella cingulata* (Stonem.) Spauld. and Schrenk, anamorph *Colletotrichum gloeosporioides* (Penz.) Sacc. (4). This fungus is frequently reported world wide as a pathogen on a wide range of host plants in both temperate and tropical climates (though most frequently in warmer climates). Some of the more common hosts in addition to apple are: Annona, banana, cacao, Camellia, Capsicum, cherry, citrus, coffee, grape, lupin, mango, pawpaw, pear, Piper, rubber, tea, tomato, and yam (4). Many wild plants also serve as hosts, and the fungus can persist in plant debris and soil as a saprophyte (4). Conidia are spread by water splash, windblown rain, and insects. Ascospores, which are forcibly discharged from the perithecium at maturity, are airborne (1).

CONTROL: Fungicide sprays are adequate to protect fruit from infection. Benlate plus Manzate 200 (2-3 oz. Benlate plus 12 oz. Manzate 200 per 100 gallons of water), Benlate plus Captan (2-3 oz. Benlate plus 12-16 oz. of Captan 50WP per 100 gallons of water), Captan 50WP (2 lbs. per 100 gallons water) are all registered for use on apple. Fungicides for bitter rot control should be applied every 7-14 days from the time fruits are beginning to swell until harvest, though Manzate 200 should not be used in the tank mix closer than 30 days prior to estimated harvest, which is late June to early July in the Gainesville area (3). Fungicide should be applied to the point of runoff, equivalent to 200-500 gallons per acre depending on the density of the planting.

Sanitation can also help control bitter rot. Mummies (dried bitter rot-infected fruits which remain on the tree throughout the winter) should be removed along with rotted fruit on the ground. Removal of cankered branches is also helpful in reducing inoculum.

SURVEY AND DETECTION: Look for brown circular lesions on fruit (Fig. 1). Once lesions enlarge to about 0.75 in. (1.90 cm.) diameter, dark fruiting structures (acervuli) bearing salmon colored masses of conidia are visible in the middle of the lesions. Fruiting bodies often develop in a concentric ring pattern.

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